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Correlation and path analysis study in Cowpea (*Vigna unguiculata* (L.) Walp.)

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Abstract
A field experiment was conducted during kharif 2016 at Cotton Research Station, JAU, Junagadh (Gujarat). The experiment was laid out in Randomized Complete Block Design with three replications. The present investigation was carried out on 54 diverse genotypes of cowpea to study the correlations and path coefficient for different traits *viz.*, Days to 50 per cent flowering, Days to first green pod picking, Number of primary branches per plant, Plant height (cm), Pod length (cm), Pod width (cm) Number of pods per plant, Number of cluster per plant, Number of seeds per pod, Number of pods per cluster, Leaf chlorophyll content, Ten pod weight (g),Hundred fresh seeds weight(g) and Green pod yield per plant(g). Association analysis between green pod yield per plant and other thirteen quantitative characters revealed that green pod yield per plant was highly significant and positively correlated with number of pods per plant (r_g=0.6812, r_p=0.6467) and ten pod weight (r_g=0.2683, r_p=0.2600) both at genotypic and phenotypic levels Path coefficient analysis indicate the highest positive direct effect on green pod yield per plant by number of pods per plant followed by number of clusters per plant and ten pod weights.

Keywords: Vegetable cowpea, genotype, correlation, path coefficient, analysis, yield

Introduction
Cowpea [*Vigna unguiculata* (L.) Walp.] is an annual, autogamous leguminous vegetable crop of India. Cowpea belongs to the order *rosales*, family *fabaceae* and the genus *Vigna*. It is a diploid species with somatic chromosome number 2n=22 (Darlington and Wylie, 1955) [2] native of West Africa (Vavilov, 1951) [19] but, Steele (1976) [18] suggested Ethiopia as the primary and Africa as the secondary centre of diversity. It has multifarious uses like as fodder, cover crop and green manure and provides high quality protein in the form of vegetable and pulse to human diet

The vegetable improvement work was initiated few decades ago in India and has resulted in the development of a large numbers of improved varieties. There are still some vegetables, which are left unexploited though they have great potential in the Indian vegetable scenario. Vegetable Cowpea is the one of them. This is possible only when diverse parents are available for breeding programme.

The aim of any breeding programme depends on genetic diversity, character association and direct and indirect effects on yield and its component characters.

The knowledge of association of yield and its components is of immense value to breeder and forms a basis for selection. It is well known that different components of yield very often exhibit considerable degree of association among themselves and with yield. Therefore, to accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the implication of the interrelationship of various characters. The concept of correlation was elaborated by Fisher (1918) [3].

Path coefficient is an excellent means of studying direct and indirect effects of interrelated components of a complex trait. Path-coefficient analysis measures the direct influence of one variable on another. Each correlation coefficient between a predictor variable and the response variable is partitioned into its component parts. The direct effect or path coefficient (a

standardized partial regression coefficient) for the predictor variable and indirect effects which involve the product of a correlation coefficient between two predictor variables with the appropriate path coefficient in the path diagram (Dewey and Lu, 1959).

Material and Method

The experiment was carried out in Randomized Block Design with three replications. The present study comprised of 54 genotypes of vegetable cowpea at Cotton Research Station, Junagadh Agriculture University, Junagadh during *Kharif* 2016. Each genotype was accommodated in a single row of 3 m length with a spacing of 60 cm × 30 cm. The recommended agronomical practices and plant protection measures were followed for the successful raising of the good crop. Data was recorded on five randomly selected competitive plants per replication for 14 parameters *viz.*, Days to 50 per cent flowering, Days to first green pod picking, Number of primary branches per plant, Plant height (cm), Pod length (cm), Pod width (cm) Number of pods per plant, Number of cluster per plant, Number of seeds per pod, Number of pods per cluster, Leaf chlorophyll content, Ten pod weight (g),Hundred fresh seeds weight(g) and Green pod yield per plant(g). Correlation coefficient were calculated by the formula given by Miller *et al.* (1958) and path coefficient analysis was worked out as per the method suggested by Dewey and Lu (1959).

Result and Discussion

The phenotypic and genotypic correlation coefficients (Table 1) were estimated for 14 characters using 54 vegetable cowpea genotypes to find out the association of green pod yield per plant with other yield contributing characters. The result of present investigation revealed that the green pod yield per plant showed positively associated with number of pods per plant and ten pod weight both at genotypic and phenotypic levels. The green pod yield per plant had also highly significant and positive correlations at genotypic level and significant and positive correlation at phenotypic level with number of cluster per plant. The green pod yield per plant showed significant and positive association with pod length of genotypic level only.

The positive genotypic association has been reported between green pod yield per plant and number of pods per plant (Siddique and Gupta, (1991) [15], Altinbas and Sepetoglu, (1993) [1], Naveen *et al.* (1998) [10], Kutty *et al.* (2003) [6], Subbiah *et al.* (2003) [17], Venkatesan *et al.* (2003) [20], Pal *et al.* (2004) [11], Patil, *et al.* (2006) [12], Nwofia *et al.* (2013), Thus, on the basis of correlations number of clusters per plant,number of pods per plant and ten pod weight were proved to be the outstanding characters influencing green pod yield in vegetable cowpea and needs to be given importance in selection to achieve higher green pod yield.

The green pod yield per plant had non-significant and negative correlation both at genotypic and phenotypic levels with number of primary branches per plant, days to 50% flowering, number of pods per cluster, days to first picking and plant height.

Subbiah *et al.* (2003) [17]; while days to first green pod picking had negative and significant correlation at both genotypic and phenotypic levels with green pod yield per plant and numbers of pods per plant. The negative genotypic association has been reported between days to first picking and green pod yield per plant and number of pods per plant by Kutty *et al.*, (2003) [6], and Pal *et al.* (2004) [11]

The present results on correlation coefficient thus, revealed that the number of pods per plant, ten pod weight, number of cluster per cluster and pod length were the most important attributes and may contribute considerably towards higher green pod yield. The interrelationship among yield components would help in increasing the yield levels and therefore, more emphasis should be given to these components while selecting better types in vegetable cowpea.

The genotypic correlation coefficients were worked out between green pod yield per plant and each of the eleven causal variables and among themselves to study the direct and indirect effects on green pod yield per plant. The data on the direct and indirect effects of these variables on green pod yield per plant are presented in Table 2

In the present study, the path coefficient analysis revealed that number of pods per plant and number of clusters per plant exhibited highly significant and positive direct effects on green pod yield per plant. Whereas, pod length and ten pod weights showed significant and positive direct effects on green pod yield per plant. Thus, these characters turned-out to be the major components of green pod yield and direct selection for these traits will be rewarding for yield improvement. Similar results were reported by Siddique and Gupta (1992) [16], Sawant (1994) [14], Kutty *et al.* (2003) [6] and Venkatesan *et al.* (2003) [20], Mittal and Paramjit (2005) [9], Kumari *et al.* (2010) [5], Manggoel *et al.* (2012) [7], Sahai *et al.* (2012) [13], for number of pods per plant; Misra *et al.* (1994) [8], Kar *et al.* (1995) [4] and Yahaya *et al.* (2005) [21] for pod length for pod width.

It was clear from the path analysis that the maximum direct as well as appreciable indirect influences were exerted by number of cluster per plant, pod length, ten pod weight and number of pods per plant. These characters also exhibited significant and positive association with green pod yield per plant and hence, they may be considered as the most important yield contributing characters and due emphasis should be placed on these components while selecting for high yielding types in vegetable cowpea. Other characters *viz.*, days to 50% flowering, pod width and leaf chlorophyll content exhibited high indirect effect on green pod yield per plant.

Table 1: Genotypic (r_g) and Phenotypic (r_p) correlation coefficient among fourteen characters of vegetable cowpea genotype

Character		Green pod yield per plant	Days to 50% flowering	Days to first green pod picking	Number of primary branches per plant	Plant height (cm)	Pod length (cm)	Pod width (cm)	Number of pods per plant	Number of clusters per plant	Number of seeds per pod	Number of pods per cluster	Leaf chlorophyll content	Ten pod weight (g)	100 - fresh seed weight(g)
Green pod yield per plant	r_g	1.0000	-0.1828	-0.1507	-0.0089	-0.0241	0.2051*	0.0663	0.6812**	0.3247**	0.0878	-0.0206	0.1021	0.2683**	0.1464
	r_p	1.0000	-0.1764	-0.1432	-0.0087	-0.0230	0.1755	0.0497	0.6467**	0.3136*	0.0835	-0.0242	0.1022	0.2600**	0.1334
Days to50% flowering	r_g		1.0000	0.3823**	-0.0173	0.0173	0.1930	0.0020	-0.4241**	-0.0250	0.1273	0.0078	-0.0951	0.0451	0.0991
	r_p		1.0000	0.3479**	-0.0089	0.0251	0.1531	-0.0022	-0.3872**	-0.0235	0.1171	-0.0126	-0.085	0.0372	0.0950
Days to first green pod picking	r_g			1.0000	0.2629**	0.1094	0.1665	0.1428	-0.1010	-0.1267	-0.1474	0.039	0.0585	0.0632	0.4530**
	r_p			1.0000	0.2517*	0.1003	0.1551	0.1437	-0.0989	-0.1238	-0.1412	0.0410	0.0574	0.0621	0.4266**
Number of primary branches per plant	r_g				1.0000	0.2733*	0.0774	0.3921**	0.0636	-0.0002	-0.0140	0.2325*	0.2547**	-0.2408*	0.2861*
	r_p				1.0000	0.2706*	0.0638	0.3747**	0.0615	-0.0008	0.0114	0.2280*	0.2487*	-0.2398*	0.2726*
Plant height(cm)	r_g					1.0000	0.1907	0.2824**	-0.0427	0.1077	0.2270*	0.3032*	0.3041*	0.0421	0.2523
	r_p					1.0000	0.1750	0.2647**	-0.0445	0.1056	0.2118*	0.2941*	0.2925*	0.0399	0.2405
Pod length(cm)	r_g						1.0000	0.4092**	0.006	-0.2012*	0.2591**	0.2251*	-0.0143	0.2021*	0.4132**
	r_p						1.0000	0.3753**	0.0138	-0.1860	0.2447*	0.2067*	-0.0168	0.1938	0.3816**
Pod width(cm)	r_g							1.0000	0.0093	0.0733	-0.0652	0.3990**	0.0666	0.1021	0.4830**
	r_p							1.0000	0.0125	0.0666	-0.0575	0.3844**	0.0561	0.0973	0.4516**
Number of pods per plant	r_g								1.0000	0.2237*	0.0312	0.1361	-0.0746	0.1464	0.1833
	r_p								1.0000	0.2185*	0.0325	0.1282	-0.0747	0.1462	0.1758
Number of clusters per plant	r_g									1.0000	-0.0808	0.0080	0.1898	0.0351	0.1295
	r_p									1.0000	-0.0810	0.0059	0.1870	0.0346	0.1306
Number of seeds per pod	r_g										1.0000	0.2576**	0.0724	0.0531	-0.0057
	r_p										1.0000	0.2450*	0.0660	0.0498	-0.0105
Number of pods per cluster	r_g											1.0000	-0.0159	-0.1730	0.0984
	r_p											1.0000	-0.0186	-0.1712	0.0844
Leaf chlorophyll content	r_g												1.0000	0.0691	0.3450**
	r_p												1.0000	0.0699	0.3398**
Ten pod weight (g)	r_g													1.0000	0.2839*
	r_p													1.0000	0.2771*
100 – fresh seed weight(g)	r_g														1.0000
	r_p														1.0000

Table 2: Genotypic Path Coefficient analysis showing direct and indirect effect of different showing characters on green pod yield per plant on vegetable cowpea

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.1551	-0.0199	0.0003	-0.001	0.061	0.0003	-0.3276	-0.005	0.0018	-0.0014	-0.0231	0.0043	-0.0277	-0.1828
2	0.0593	-0.0519	-0.0041	-0.0062	0.0526	0.0182	-0.078	-0.0252	-0.0021	-0.0072	0.0142	0.0061	-0.1264	-0.1507
3	-0.0027	-0.0136	-0.0156	-0.0155	0.0235	0.05	0.0491	0.0001	-0.0002	-0.0427	0.0618	-0.0232	-0.0798	-0.0089
4	0.0027	-0.0057	-0.0043	-0.0566	0.0602	0.036	-0.033	0.0214	0.0033	-0.0556	0.0738	0.0041	-0.0704	-0.0241
5	0.0299	-0.0086	-0.0012	-0.0108	0.3159	0.0521	0.0046	-0.0400	0.0037	-0.0413	-0.0035	0.0195	-0.1153	0.2051*
6	0.0003	-0.0074	-0.0061	-0.016	0.1293	0.1274	0.0072	0.0146	-0.0009	-0.0732	0.0161	0.0098	-0.1348	0.0663
7	-0.0658	-0.0052	-0.0010	0.0024	0.0019	0.0012	0.7725	0.0445	0.0004	-0.025	-0.0181	0.0141	-0.0512	0.6812**
8	-0.0039	0.0066	0.0001	-0.0061	-0.0636	0.0093	0.1728	0.1988	-0.0012	-0.0015	0.046	0.0034	-0.0361	0.3247**
9	0.0198	0.0077	0.0002	-0.0128	0.0819	-0.0083	0.0241	-0.0161	0.0143	-0.0473	0.0176	0.0051	0.0016	0.0878
10	0.0012	-0.002	-0.0036	-0.0171	0.0711	0.0508	0.1051	0.0016	0.0037	-0.1835	-0.0039	-0.0167	-0.0275	-0.0206
11	0.0148	-0.003	-0.004	-0.0172	0.0045	0.0085	-0.0576	0.0377	0.001	0.0029	0.2426	0.0067	-0.0963	0.1021
12	0.007	-0.0033	0.0038	-0.0024	0.0638	0.013	0.1131	0.007	0.0008	0.0317	0.0168	0.0963	-0.0792	0.2683**
13	0.0154	-0.0235	-0.0045	-0.0143	0.1305	0.0616	0.1416	0.0258	-0.0001	-0.0181	0.0837	0.0273	-0.2791	0.1464

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